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Interactive comment on "Terrestrial ecosystems response to future changes in climate and atmospheric CO_2 concentration" *by* V. K. Arora and G. J. Boer

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We thank both reviewers for their positive comments.

Anonymous reviewer # 1 has not suggested any revisions to the manuscript.

Reviewer # 2 (G. Sampaio) has suggested that we clarify few statements. We will revise our manuscript to clarify these statements as explained in the point-by-point response below.

Q1. Page 3589, L16: "The difference in the local land carbon change : : : for the

"moderately" forced scenario RCP4.5". I think important put an example with numbers to be clearer.

A. The numbers 2.6, 4.5 and 8.5 represent the radiative forcing for each scenario in year 2100. The RCP 4.5 scenario lies between the RCP 2.6 and RCP 8.5 scenarios with respect to its radiative forcing. Hence we used the term "moderately".

Q2. Page 3593, L02-04: "The scenario fluxes for the tropical region (between 30oS and 30oN) are either near neutral or indicate a modest carbon loss to the atmosphere for the RCP 2.6 case." Why is there more carbon loss to the atmosphere for the RCP 2.6 case and less carbon loss for the others RCPs?

A. The three RCP scenarios have three different CO2 concentration pathways as shown in Figure 1a, with highest (lowest) CO2 concentration in the RCP 8.5 (2.6) scenario. The tropical region between 30oS and 30oN indicates a moderate carbon loss in the RCP 2.6 scenario, but near neutral carbon exchange in the RCP 4.5 and 8.5 scenarios, because the CO2 fertilization effect is weakest in the RCP 2.6 scenario. As long as photosynthesis is not soil moisture limited higher CO2 concentrations will yield higher photosynthesis rates. This is seen in Figures 5 a,b and c where the increase in vegetation biomass over Central Africa is largest in the RCP 8.5 scenario. The loss of carbon over the South American continent is compensated differently by the gains over other tropical regions. As a result, cumulatively over the 2006-2100 period, the tropics lose carbon in the RCP 2.6 scenario but remain near neutral in the RCP 4.5 and 8.5 scenarios.

Q3. Page 3593, L18: Change ": : :RCM 8.5" to ": : :RCP 8.5".

A. Thank you for pointing this typographical error.

Q4. Figure 4: the changes are calculated as the difference between 2006-2015 and 2091-2100, but the Figure caption mentions the period 2006-2100.

A. Thank you for pointing this. We will revise the figure titles accordingly.

Q5. Page 3594, L15-18: The vegetation biomass is increasing over central Africa in the RCP 4.5 and 8.5 scenarios, but in the central-west of this area the precipitation and soil moisture are decreasing. Please explain.

A. Figure 4 shows the soil moisture change but not the absolute values of soil moisture. Soil moisture stress for photosynthesis in the Canadian Terrestrial Ecosystem Model (CTEM), the terrestrial carbon cycle component of CanESM2, is modelled as a function of soil matric potential which depends on the absolute soil moisture. Depending on the absolute initial value of soil moisture in a region and given the increasing CO2, photosynthesis may or may not reduce for small reductions in soil moisture. We believe this is the reason why small reductions in soil moisture in the central-west of the central African region (compared to large soil moisture reductions over the South American continent) do not cause a reduction in vegetation biomass.

Q6. Page 3595, L09 and Figure 6: ": : :future climate change". What is the period?

A. "reactivity to future climate change" in this context refers to sensitivity of land carbon change, over the 2006-2100 period, to the different climate change scenarios.

Q7. Page 3595, L08-14: I think this paragraph needs more discussion. The authors are presenting only a description of the Figure. For example, how is the response of the "reactivity" of the tropical forests?

A. We agree that this paragraph can use some more discussion.

Regions of low reactivity indicate similar carbon change across scenarios. One reason for this is the result of compensatory effects of forcings as is the case over the Amazonian region where the negative effects of higher reduction in precipitation with increasing CO2 compensate the positive effects of increased CO2 fertilization effect. Arid regions with generally low vegetation are also expected to exhibit low reactivity because regardless of the atmospheric CO2 concentration, the land carbon amount is not going to change substantially. This is the case for the Sahara region and parts of Australia.

Regions of high reactivity indicate different carbon change across scenarios. In these regions the compensatory effects of forcings are absent. These regions include the Central African region, and tropical forests of south-east Asia and the south-eastern China. Here, increasing atmospheric CO2 concentration, unlike the regions over the South American continent, does not cause large decrease in precipitation and the benefits of CO2 fertilization can be realized.

Interactive comment on Biogeosciences Discuss., 11, 3581, 2014.